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INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

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Applicant's or agent's file reference FLC 2 0362 P		FOR FURTHER ACTION See Notification of Transmittal of International Preliminary Examination Report (Form PCT/PEA/416)	
International application No. PCT/US 03/17994	International filing date (day/month/year) 09.06.2003	Priority date (day/month/year) 12.06.2002	
International Patent Classification (IPC) or both national classification and IPC B01J19/30			
Applicant SAINT-GOBAIN CERAMICS & PLASTICS, INC. et al.			
<p>1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 4 sheets, including this cover sheet.</p> <p><input checked="" type="checkbox"/> This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).</p> <p>These annexes consist of a total of 5 sheets.</p>			
<p>3. This report contains indications relating to the following items:</p> <p>I <input checked="" type="checkbox"/> Basis of the opinion</p> <p>II <input type="checkbox"/> Priority</p> <p>III <input type="checkbox"/> Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</p> <p>IV <input type="checkbox"/> Lack of unity of invention</p> <p>V <input checked="" type="checkbox"/> Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</p> <p>VI <input type="checkbox"/> Certain documents cited</p> <p>VII <input type="checkbox"/> Certain defects in the international application</p> <p>VIII <input type="checkbox"/> Certain observations on the international application</p>			
Date of submission of the demand 09.01.2004		Date of completion of this report 17.09.2004	
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465		Authorized Officer Thomasson, P Telephone No. +49 89 2399-8339 	

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT**

International application No. **PCT/US 03/17994**

I. Basis of the report

1. With regard to the **elements** of the international application (*Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*):

Description, Pages

1, 4-10 as originally filed
2, 3 received on 01.04.2004 with letter of 30.03.2004

Claims, Numbers

1-15 received on 01.04.2004 with letter of 30.03.2004

Drawings, Figures

1-6 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
☐ the language of publication of the international application (under Rule 48.3(b)).
☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
☐ filed together with the international application in computer readable form.
☐ furnished subsequently to this Authority in written form.
☐ furnished subsequently to this Authority in computer readable form.
☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
☐ the claims, Nos.:
☐ the drawings, sheets:

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5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	1-15
	No: Claims	
Inventive step (IS)	Yes: Claims	1-15
	No: Claims	
Industrial applicability (IA)	Yes: Claims	1-15
	No: Claims	

2. Citations and explanations

see separate sheet

**INTERNATIONAL PRELIMINARY
EXAMINATION REPORT - SEPARATE SHEET**

International application No. PCT/US 03/17994

Re Item V

Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Closest prior art.

D1 (BE-A-481 212) discloses a ceramic packing element with first and second concave external surfaces which are connected by convex surfaces; the packing element possesses furthermore an uniform cross-section with three passageways and is symmetrical with regard to an axis passing through its center (see D1: International Search Report and figure 6). The ratio of **width to length** of the ceramic packing according to D1 seems to be much smaller than 1 (see D1: figure 1).

2. Novelty.

The subject-matter of claims 1 and 15 differs from D1 in that (1) at least one of the passage is being **kidney bean-shaped** and (2) the element possesses a ratio of **width to length** dimensions being from **1,5:1 to 5:1**.

3. Inventive step.

The technical problem to be solved against D1 is to improve the heat-exchange properties of packing element and keeping a **pressure drop** as low as possible (see the present application on page 1, paragraph 2). The applicant had made plausible that the subject-matter of claims 1 and 15 solves the above technical problem (see in particular on page 9, paragraph 36: low pressure drops). Since neither D1 nor the remainder of the prior art discloses nor suggests the combination of the technical features of claims 1 and 15, an inventive step can be recognized (Article 33(3) PCT).

REPLACED BY
ART 34 AMDT

application is as a bed topping material which is intended to keep material within a bed confined with limited ability to be entrained in a gas flow or to be caused to move around by such a flow. Such entrainment or abrasion typically causes significant losses to the material in the bed.

[0003] Ceramic packing elements can be produced by an extrusion or a dry-pressing process and hence have an essentially uniform cross-section along one axial direction which provides an axis of symmetry for the element. Several such shapes have been described in the art ranging from the very simple to the complex. All are based on an essentially cylindrical shape and differ basically in the internal structure within the cylindrical shape. The simplest structure is a basic cylinder with no internal structure at all. This type of structure is often called a Raschig ring and has been known for many years. At the other end of the complexity scale are the structures described in US Design Patent 455,029 and US Pat. No. 6,007,915. Between the extremes there are simple wagon-wheel shapes such as are described in US Pat. Nos. 3,907,710 and 4,510,263. Others show deformed cylindrical structures, such as those described in US Pat No. 5,304,423.

[0004] For certain applications, such as bed limiters, the pressure drop is less important since the thickness of the bed limiter layer is relatively small. It is far more important that the packing elements do not nest together and still allow free passage of gases while being heavier than the elements comprising the bed on which the packing elements rest and whose extent is thereby limited.

SUMMARY OF THE INVENTION

[0005] In accordance with one aspect of the present invention, a ceramic packing element is provided. The element has an essentially uniform cross-section along an axis passing through a center of the element and about which the element is symmetrical defining a length of the element. First and second concave external surfaces are provided at the ends of height and width axes

respectively, perpendicular to the length direction. The concave surfaces are connected by surfaces that are selected from (i) convex surfaces and (ii) convex surfaces connected to the concave surfaces by relatively short intermediate flat surfaces. The element is provided with at least three through passages in the length direction.

[0006] In accordance with another aspect of the invention, a method of forming a bed of packing elements is provided. The method includes extruding a mixture comprising one or more ceramic-forming components, sectioning the extruded mixture to form sections, firing the sections to form packing elements. Each of the packing elements has first and second concave external surfaces at the ends of height and width axes respectively perpendicular to a length direction. The concave surfaces are connected by surfaces that are selected from convex surfaces and convex surfaces connected to the concave surfaces by relatively short intermediate flat surfaces. The element is provided with at least three through passages in the length direction. The method further includes assembling a bed of packing elements including a plurality of the fired packing elements.

[0007] In accordance with yet another aspect of the present invention, a ceramic packing element is provided. The element has first and second opposed generally planar surfaces. First and second concave external surfaces are provided at the ends of height and width axes, respectively, of the planar surfaces. The concave surfaces are connected by surfaces that are selected from (i) convex surfaces and (ii) convex surfaces connected to the concave surfaces by relatively short intermediate flat surfaces. The element is provided with a plurality of through passages in a length direction, at least one of the through passages having a cross section defined by a first arcuate surface and a second arcuate surface, the second arcuate surface being longer than the first arcuate surface and located generally parallel thereto.

REPLACED BY
ART 34 AMDT.What is claimed is:

1. A ceramic packing element (1, 6, 8) having an essentially uniform cross-section along an axis (*l*) passing through a center (*C*) of the element and about which the element is symmetrical defining a length (*L*) of the element, and characterized by:
first and second concave external surfaces (2, 3) at the ends of height and width axes (*h*, *w*) respectively perpendicular to the length direction, said concave surfaces being connected by surfaces that are selected from convex surfaces (4) and convex surfaces (4) connected to the concave surfaces by relatively short intermediate flat surfaces (7), and the element being provided with at least three through passages (5) in the length direction.
2. An element (1, 8) according to claim 1 in which the concave surfaces (2, 3) are connected directly to convex surfaces (4).
3. An element (1, 6, 8) according to Claim 1 or 2 in which width and height dimensions (*W*, *H*) of the element are unequal with the ratio of width to height being from 1.25:1 to 3:1.
4. An element (1, 6, 8) according to Claim 3 in which width and height dimensions (*W*, *H*) of the element are in a ratio of from about 1.3:1 to 2.0:1.
5. An element (1, 6, 8) according to any one of Claims 1-4 in which the ratio of a width dimension (*W*) to the length (*L*) is from 1.5:1 to 5:1.
6. An element (1, 6, 8) according to any one of Claims 1-5 in which the element is provided with from 3 to 275 passageways.
7. An element (1, 6, 8) according to any one of Claims 1-6 in which at least a plurality of the passageways (5a, 5b, 5c, 5d) are round in cross-section and a diameter (*D*) of each round passage is less than about one half of the height (*H*) of the element.
8. An element (1, 6) according to Claim 7 in which the passageways have identical dimensions.

9. An element (8) according to any one of Claims 1-7 in which at least one the passageways (5e) is kidney bean-shaped in cross-section.
10. An element (8) according to Claim 8 in which the at least one kidney bean-shaped passageway (5e) has a largest dimension (D) which is up to about $\frac{2}{3}$ of the height (H) of the element.
11. An element (1, 6, 8) according to any one of Claims 1 to 10 in which a total cross-sectional area of the passages represents from 20 to 75% of the total cross-sectional area of the element.
12. An element (1, 6, 8) according to Claim 11 in which a total cross-sectional area of the passages represents from 30 to 67% of the total cross-sectional area of the element.
13. An element (1, 6, 8) according to any one of Claims 1 to 12 in which the ceramic is a porous material.
14. An element (8) according to any one of Claims 1 to 13 in which the passages include a plurality of first passages (5a, 5c, 5d) having a first shape, and at least one second passage (5e) having a kidney bean shape, the at least one kidney bean-shaped passage being positioned intermediate at least one of the plurality of first of passages and the center of the element.
15. An element (1, 6, 8) according to any one of Claims 1 to 14 in which a ratio of height to width of the element, H:L is from about 5:1 to 15:1.
16. An element (8) according to Claim 15 in which H:L is about 8:1.
17. A method of forming a bed of packing elements comprising:
 - extruding a mixture comprising one or more ceramic-forming components;
 - sectioning the extruded mixture to form sections;
 - firing the sections to form packing elements (1, 6, 8), wherein each of the packing elements is characterized by first and second concave external surfaces (2, 3) at the ends of height and width axes (h, w)

respectively perpendicular to a length direction (L), said concave surfaces being connected by surfaces that are selected from convex surfaces (4) and convex surfaces (4) connected to the concave surfaces by relatively short intermediate flat surfaces (7), and the element being provided with at least three through passages (5) in the length direction;

assembling a bed of packing elements which includes a plurality of the fired packing elements.